# Coding the Self:
## *The Infopolitics and Biopolitics of Genetic Sciences*

BY COLIN KOOPMAN

At the dawn of the twenty-first century, when it was announced that the mapping of the human genome had been completed, it seemed for a brief moment as if we were at last on the panoramic precipice of being able to solve the wonderful riddle of the relationship between our genes and our selves. Nearly two decades later, the biological sciences have yet to deliver their promised keys to human nature. However, rather than dissipating in disappointment, the riddle of genetic selfhood has only increased in appeal. We are now as fascinated as ever by the role genes play in the formation of who we are.

Accompanying our abiding interest in our genetic human nature is a growing recognition of the increasingly complicated challenges of the political and ethical implications of the sciences and technologies of our genes. How should we analyze and assess these challenges?

In considering this question, we should recognize straightaway that the issues at stake derive from diverse scientific vantage points. I will use the term *genetic sciences* throughout this essay as a unifying umbrella under which to discuss the concerns common among genetics, genomics, and the growing number of scientific projects presented under the banner of "postgenomics." But it is by no means the case that these varied scientific projects are all, at bottom, somehow the same. There is instead increasing complexity in the very practice of the genetic sciences. We should make sure that our approach to analyzing the political and ethical implications of these sciences is able to countenance this complexity.

In this essay, I present and compare three models for conceptualizing the political and ethical challenges of contemporary genetic sciences. All three are relevant to and valuable for the study of the complex challenges we face in the sciences of genetics, genomics, and postgenomics. The three analytical approaches I shall consider are the *state-politics* model, the *biopolitical* model, and the *infopolitical* model. If we compare these models in terms of their influence in contemporary discussions of these challenges, then we find that one is by far the dominant approach, another is gaining in importance, and the third is almost entirely neglected. As I will demonstrate, this neglect of the third model is unjustified but also, fortunately, quite unnecessary.

The first model, that of the politics of the state, is both familiar and dominant. According to this view, politics takes the form primarily of laws, regulations, prohibitions, mandates, coercions, and perhaps even state-sanctioned force. There are abundant examples of state-and-law politics in the context of debates in the genetic sciences: the legality of genetic cloning, guidance for germline genetic engineering, regulation of using genetic information for risk assessment in insurance, and so on. These debates are of undeniable importance. They are also often framed in a vocabulary that is conceptually quite familiar: legal prohibitions, administrative policies, actuarial estimates. Given the familiarity of this vocabulary and how comfortable we are in thinking about politics based on this model, we focus on these dimensions of the politics of genetic sciences at the expense of attending to other, equally important debates concerning the implications of genetics.

We face a recurring challenge whenever new sciences and technologies emerge: new technosciences produce new consequences prior to our being able to govern those consequences through tools like legal regulation. How should we understand that interim space where power is operative prior to the arrival of the regulatory

Colin Koopman, "Coding the Self: The Infopolitics and Biopolitics of Genetic Sciences," in *For "All of Us"? On the Weight of Genomic Knowledge,* ed. J. M. Reynolds and E. Parens, special report, *Hastings Center Report* 50, no. 3 (2020): S6-S14. DOI: 10.1002/hast.1150

*Genetics, genomics, and postgenomics are intensively informational sciences. But widespread recognition of this is not accompanied by widespread affirmation of the importance of attending to the politics of their informational dimensions.*

state and its binding laws? In light of questions like this, we sometimes need to pursue other models of analysis. In the context of recent developments in the genetic sciences, and especially in the context of their technological development, the models of biopolitics and infopolitics can be valuable for assessing novel challenges.

The bulk of this essay is devoted to descriptions of how these two models can help us think about the consequences of genetics that arise before laws and regulations are practicable. But before turning to those descriptions, I want to offer a preliminary overview of the biopolitics and infopolitics models, in part because both are less familiar than the state-political model.

What, then, is biopolitics? Biopolitics considers questions of politics and of power as concentrated on humans specifically as living beings. Whereas the state-politics model may implicitly accept that the humans governed by our laws are living beings, the entire point of the biopolitics model is to come to terms with power transactions in which humans matter precisely because they are living beings, that is, healthy or sick, flourishing or dying.[1] The institutional exemplar of biopolitics is the public health agency, particularly in its efforts to improve population-level health regardless of legal statuses such as citizenship. A state-politics approach to property disputes may never explicitly concern itself with the biological dimensions of human property owners, whereas the biopolitics of genetic patents involves questions of politics that are focused on the ownership of genetic materials insofar as these affect health, wellness, longevity, and vitality itself.

What, next, is infopolitics? Infopolitics focuses on questions of politics and power in terms of the data and information that are today increasingly central to how we live our lives.[2] Infopolitics is a politics of our information, or a politics addressed to human beings as subjects of data, that is, as creatures whose lives are significantly structured by, and described in terms of, their data. Infopolitics, so defined, clearly extends beyond genetic data: it is a model for understanding issues as wide-ranging as the role of fake news in elections, the function of social media in redefining selfhood for youth, and the role of psychometric evaluations (intelligence testing, personality assessment, and so on) in determining educational and employment opportunities. Focusing on the infopolitics of genetic research provides a way of drawing attention to certain questions that are not easily addressed by the state-political and biopolitical models.

Consider, for example, the consequences of determining a specific computed sequence of genetic material (rather than other candidate sequences) as a "gene" and then leveraging that determination into an assessment of genetic predispositions for certain cognitive or personality abilities. Even with this single example, there is a panoply of infopolitical issues concerning genomic and genetic data management as well as interpretation and communication. We could, of course, produce hypothetical examples that would demand state-political scrutiny (for instance, using genetic predisposition tests to overtly discriminate against certain pupils in public education) and biopolitical analyses (for example, using genetic analyses as a basis for distributing health benefits to certain populations). I do not deny the importance of these issues. My concern is only to emphasize some of the subtler uses and effects of genetic sciences that are not easily understood as state-political violations or biopolitical projects and that raise ethical and political questions that we should not neglect.

At a more concrete level, what kinds of questions does infopolitics help bring into view? I will consider a more complex example in the final section, but for a quick preliminary example, consider the rise of direct-to-consumer genetic testing. Such tests are offered by a range of firms issuing a variety of promises, including Karmagenes ("understand your nature and nurture"), Orig3n ("discover the genetic traits that set you apart"), and the current market leader 23andMe ("23 pairs of chromosomes, one unique you").[3] Most of the products offered by many of these companies are well ahead of the regulatory curve of state-centered politics. In being directly marketed to consumers for characteristics extending beyond biomedical health, their products are not biopolitical in every respect. And yet the tests raise important questions of ethics and politics. How do test manufacturers define the personality traits and cognitive abilities that they relate to genetic profiles, and with what effects? How do the reports prepared by these firms present probability estimates of correlations between data lying along two or more distinct dimensions (such as behavioral dimensions and genetic dimensions), and with what effects? If such questions deserve their airing, and I believe they do, then we are in need of models of ethical and political analysis adequate to the specificity of these complex issues.

This brings us back to the issue of the comparative influence of the three models under consideration. The state-political model continues to dominate thinking about the extraordinary constellation of questions prompted by the genetic sciences. At the same time, the biopolitical model's influence is increasingly felt in expressions of concern about the politics of these sciences. My primary concern here, however, is the need for a more explicit recognition and more sophisticated conceptual modeling of the infopolitical dimensions of the genetic sciences. Although genetics, genomics, and postgenomics are all intensively informational sciences—and have been for more than half a century—the widespread recognition that they are is not accompanied by a widespread affirmation of the importance of attending to the politics of their specifically informational dimensions.

To make the case for the infopolitical model, I first describe the recent focus on biopolitical analysis in the domain of the genetic sciences, a development that offers an analogy and a precedent for the expansion of our models of political and ethical analyses to include not only the state-political model but also the biopolitical model and, now, in addition, the infopolitical model. I then briefly consider the history of the role of information in modern genetic sciences. Last, I turn to my central task of demonstrating the need for a model of analysis attentive to the politics of information itself.

## Biopolitics and Genetics

Recent scholarship focusing on the increasing role of genetics in the constitution of the self has conceptualized this relationship with ideas such as *biological citizenship* and *biosociality*.[4] According to many of these analyses, genetically driven definitions of selfhood offer the latest approach from within the biological sciences to anchor biopolitics. Scholars pursuing this approach have frequently oriented their work by way of the idea of biopolitics as developed by Michel Foucault.[5]

To describe the crux of the biopolitical model, I turn directly to Foucault's work. An immediate caveat is, however, requisite. Some readers may have already encountered Foucault's name in a form according to which he is a skeptical denier of the truth of the modern sciences. This caricature is unfortunate (though perhaps explainable as an aftereffect of the fiery debates over so-called postmodernism that raged in intellectual circles a few decades ago). Such presentations of Foucault's work fail to note that he was trained as, and continued throughout his life to be, a historian of science. Foucault as the historian of science was not at all a skeptic who denied scientific truths. Rather, he inquired into the "genealogies," to use his term, of how we came into possession of the scientific truths we live by today.[6]

Consider in this light Foucault's influential analyses of biopolitics. These genealogies were the product of intensive historical research of eighteenth- and nineteenth-century sciences and the stretch of their long shadow into today. On the basis of these investigations, Foucault argued that there emerged in that period a politics of meticulous attention to *life*. Circulating between practices as diverse as epidemiology, education, and psychiatry, this was a politics geared to the adjustment of the processes of living—a whole political apparatus for the regulatory modulation of disease, sanitation, hygiene, and their multiple constituents.[7] These operations, moreover, always modulate life as it belongs to an "us" rather than a "me"—their object was always a group, or, more technically, a population. Thus Foucault's biopolitics is a synthetic tripartite notion: it is a model of the politics of the *adjustment* of *populations* of *living* beings.[8]

According to Foucault, biopolitics is first and foremost a productive politics, rather than a repressive politics that limits, keeps down, or takes something away from people.[9] The productivity of biopolitics is clearest in the way it works to foster life and to improve health. The promotional efforts of public vaccination drives are exemplary. Already implied in any such politics, however, is a politics for disallowing life—or, less sinister but equally dangerous, a politics for neglecting life. Buried within biopolitics is a trajectory for the differential treatment of separate populations of living beings. Sticking with the example of public vaccination campaigns, we can perceive differential treatment in the widespread neglect of children from developing nations who remain unvaccinated against common and preventable diseases like malaria, measles, and pertussis. It is precisely because of such differentials that the management of living populations is fraught with political and ethical challenges.

Though numerous scholars over the past few decades have insightfully deployed Foucault's model of biopolitics for inquiry into the politics of genetic sciences, Foucault himself said very little about genetics, in particular, contemporary molecular genetics. This is mostly because Foucault's historical account of the biopolitics of the life sciences is focused primarily on the nineteenth century and sharply breaks off before the dawn of the twentieth century. Foucault's own end point provokes and encourages further genealogical investigations going forward into twentieth-century sciences of genetics.

Although there are many issues concerning how life is represented within these more contemporary iterations of the genetic sciences, I focus here on just one. It involves

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a major development within the genetic sciences that the biopolitical model does not, and I believe cannot, account for. The success of the genetic sciences from the middle of the twentieth century up until today has been dependent upon information, coding, and programming—in short, an entire data epistemology. This feature of modern genetics contrasts strikingly with the characteristics of the nineteenth-century life sciences that were Foucault's focus. If this contrast is not merely incidental, then a third model of political analysis may prove useful alongside other thus-far more-familiar models. But before turning to that model, we need to consider the history of the biological sciences beyond Foucault's stopping point and into the twentieth century. Furthering the historical analysis in this way is requisite because we can come to grips with the truly extraordinary complexity of the genetic sciences only in the light of their history.[10]

### The Genealogy of Genetic Code

The most widely known and one of the most influential scientific landmarks for the crucial idea of genetic code is James Watson and Francis Crick's development of the double helix model of DNA. It is not accidental that, in the publications in which, in 1953, Watson and Crick announced their discovery of DNA's double-helical structure, they surmised that it "seems likely that the precise sequence of the bases is the code which carries the genetical information."[11] This phrasing draws attention to the fact that Watson and Crick could comfortably assume that the basic objects of research in genetics were processes of information transfer. Indeed, this was an assumption so secure that they did not even recognize a need to argue for it in their description of their research as oriented by two desiderata: "A genetic material must in some way fulfil two functions. It must duplicate itself, and it must exert a highly specific influence on the cell."[12] Watson and Crick just took it for granted that "influence" was a matter of information transfer. If genetic material consisted in the specificity of sequences of bases, they could make the inference to their crucial conclusion that "the sequence is the only feature which can carry the genetical information."[13]

In Watson's later account of the modeling of DNA's structure, he made explicit that the functional movement at the core of genetic research, namely, from DNA to RNA to protein, was one that "did not signify chemical transformations, but instead expressed the transfer of genetic information."[14] Two years later, François Jacob, winner of a 1965 Nobel Prize for his contributions to genetics, would summarize the going view on the first page of *The Logic of Life*: "Heredity is described today in terms of information, messages and code."[15] What is important about such statements is that midcentury molecular biology did not position information as a mere metaphor for underlying physicochemical processes that are taken to be real. Physicochemical reality itself was conceptualized functionally as information transfers. This conceptualization persists today, as noted by Richard Dawkins: "The genetic code is truly digital, in exactly the same sense as computer codes. This is not some vague analogy, it is the literal truth."[16] This point is so crucial that it bears repeating. *Information is not a mere metaphor for genetic material—genes, genomes, and epigenetic systems are themselves informational at their core.*

What are the historical conditions that made it possible for Watson and Crick to unproblematically rely on an informational concept of genes? This crucial question demands a complicated answer. Fortunately, the work of the late historian of science Lily Kay provides one. The crucial question driving Kay's exquisite account is this: "How did scientists come to view organisms and molecules as information storage and retrieval systems?"[17] According to her answer, an epistemology of information began to permeate the biological sciences, or at least then-cutting-edge subfields like molecular biology, in the mid-1940s. On her analysis, the famed shift in biology's focus from protein to DNA was in actuality less momentous than the prior shift to an information-centric epistemology. In considering what facilitated this epistemological transition, Kay shows that "[t]he information-based models . . . that were central to the formulation of the genetic code were transported into molecular biology from cybernetics, information theory, electronic computing, and control and communications systems."[18]

The crux of Kay's argument is that cybernetics and information theory were fundamental to postwar molecular biology. "The year 1948 was a turning point," she held.[19] That year saw the publication of Norbert Wiener's massively popular book, *Cybernetics,* and Claude Shannon's hugely influential technical paper, "A Mathematical Theory of Communication." The fathers of information theory even occasionally directly assisted in the informational reconceptualization of genetics, as evidenced by a letter from Wiener to the biologist J. B. S. Haldane, in which Wiener asserts, "If I could see heredity in terms of message and noise I could get somewhere."[20] Due in part to Wiener himself, but surely more to the mobilizable concepts and techniques of cybernetics and information theory, "[b]y the early 1950s, a number of geneticists and molecular biologists had begun to redefine organisms as cybernetic systems and to rewrite their accounts in terms of information."[21] At this point, "it became virtually impossible to think of genetic mechanisms and organisms outside the discursive framework of information."[22] As the language of genetics increasingly crept toward the information-centric language of cybernetics, it made real the truth behind Wiener's provocative idea that "there is no fundamental absolute line between the types of transmission which we can use for sending a telegram from country to country and the types of transmission which at least are theoretically possible for a living organism such as a human being."[23]

Kay's history shows how information theory functioned as a primary condition of possibility for Watson and Crick's assumption that genes are essentially information-transmission apparatus. It was, she shows, because of Wiener that Watson himself could write, in a coauthored letter in *Nature* published only a few months before the famous double helix articles, of "the possible future importance of cybernetics at the bacterial level."[24]

## Infopolitics and Genetics

Just as there have been increasing calls over the past few decades for a biopolitical analysis appropriate to our biosociality and biocitizenship, a related question we need to consider seriously today is whether there is also a distinctive demand for an infopolitical analysis appropriate to our informational personhood. The midcentury genetic sciences gained epistemological legitimacy by leveraging information theory and cybernetics.[25] These informational underpinnings of genetics research persist in recent projects in genomics and even more markedly in postgenomics.[26] The genetic selves that we understand ourselves to be today are also therefore informational selves. The genealogy of genetics culminates quite consequentially in the sequenced selfhood of what I call the "informational person,"[27] or what Kay calls "informational man,"[28] or what Donna Haraway once referred to, also in relation to genetics, as a "human [that] is itself an information structure."[29] In short, if we are our genes, and our genes are data, then we are our data. If that is right, the informational persons we have become require, at least some of the time, a distinctive attention to the politics and ethics of the information that we are.

Interestingly, Kay's own argument was that the informationalization of molecular biology betrayed "an emergent form of biopower," or a "biopower of the information age."[30] Kay is surely right that we today confront a biopolitics of genetic data. Genetic data is used to modulate living populations by being deployed to foster life among some populations and to neglect its fostering among others. But we miss something crucial about the politics of genetics, as well as that of any other informationally invested science, if we conceptualize all its operations through the single lens of biopolitics. For genetic data is also used to do much else to who we are.

One thing that the genetic sciences do with tremendous success is to "format" us as subjects of genetic data. In being formatted, rendered, or organized as genetic data, we come to be defined by that data. Others address us, deal with us, or even impose burdens and benefits on us in terms of the genetic data we have become. In the distinctive work of formatting whereby our data defines who we are and who we can be, we as informational persons are subject to a whole array of political and ethical inequalities stemming from overt differential treatment or unintended disparate impact. The ways in which data is used to format, render, or organize who we are and can be are the distinctive focus of the model of infopolitics (at least when and where the work of formatting occurs outside of our modulation as living beings and outside of the laws governing us as citizens).[31]

Before detailing how the infopolitics of formatting operates within the genetic sciences, I want to establish a broader perspective on the model of infopolitics. In other recent work, I have proposed the infopolitical model as appropriate for a fuller array of political and ethical questions concerning our increasing saturation in data of all kinds, from social media profiles to state surveillance dossiers. I argue in my recent book, *How We Became Our Data*, that we have been subjects of our data, or informational persons under the sway of an infopolitics, for almost a century now.[32] In a feverish moment in the 1920s when everyone was as enthusiastic for information as we are today for data, domain after domain was turned into a space driven by and for information technology. The years from the mid-1910s to the mid-1930s saw the emergence of informational apparatus that are now, almost a century later, among the most familiar furniture of our lives—standard birth certificates, Social Security numbers, psychometric evaluations for intelligence and personality, the datafication of finance and credit, robust medical informatics, and even the datafication of long-standing identity categories of race and gender. The models that help us understand those earlier moments from the 1920s can, and should, be extended

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forward to the project of modern genetics that began in the 1950s and that remains with us today, at the very heart of who we are.

The specifically infopolitical dimensions of these sciences and technologies concern, above all, the politics of what I call "formatting." To understand the politics of formatting in the genetic sciences, consider a golden thread that runs through the history of these sciences from the emergent moment of molecular biology up to recent research in postgenomics. The thread is a seemingly obvious but remarkably important conceptual feature of the informational paradigm of genetics, genomics, and postgenomics: the fact that *genes code for what is codable*.

When we take genetic materials to be essential determinants for who we are, we are taking ourselves to be programmable creatures, that is, creatures who can be formatted as codable data. Any feature of who we are that can be programmed by genes (or, in the postgenomic perspective, by complex combinations of genetic, epigenetic, and other factors) is a feature that must itself be programmable. Out of this apparent truism of genetics unfold myriad crucial implications. To bring into view the political and ethical implications issuing from our being codable by genetic code, I want to contrast two ways of responding to this important truism.

The first response is perhaps the more obvious to spring to mind. It can be expressed in the intuition that genetics, as a science of coding, inevitably ignores those aspects of who we are that cannot be coded or programmed. The emphasis in this response is on the idea that genes can code *only* for what is codable and therefore misses important parts of who we are. This response is, at its core, suspicious of the reductive tendencies of genetic info-sciences.[33]

I find this kind of response rather unproductive. I see little reason to assume a default skepticism toward stable scientific practices. Only someone who sees merely the weight of the genomic sciences, and none of the positive value, could take this view. There are, of course, numerous exclusions and biases embedded in any collection of genetic data, but there is no reason to regard these as significantly different in kind from the typical practical obstacles that any science faces.[34]

Consider, then, a second response, one emphasizing that genes *can* code for whatever is codable. In coding who we are, our genes are taken to code us in particular ways and not in other ways. Any genetic analysis involves a host of decisions about which codings to employ and which to ignore. For example, developers of direct-to-consumer genetic tests must make decisions about how to classify and organize probabilistic data so that an individual who takes one of the tests can receive a report that they are "19.7% Iberian" and "5.5% Broadly European" or that they are genetically predisposed to "weigh about 9% less than average."[35] Such reports are the output of proprietary algorithms to which we do not have privileged access, but it is safe to assume that they involve at least the following: probability estimates derived from comparing individual genetic sequence data to enormous pools of aggregate sequence data, the decision that some of these probabilities are reportable and others are not (for instance, the decision to report a 50 percent probability that weight is predisposed to be 9 percent less than average, but not a 40 percent probability that weight is predisposed to be 12 percent less than average or a 75 percent probability that weight is predisposed to be 5 percent less than average), and the assumption (which is not at all true in any straightforward sense) that probabilistic features of populations can be meaningfully applied to individual members of those populations. These are only very basic observations concerning simple truths of any statistical science making use of probabilities in its basic operations. But what is basic is not for that reason trivial. These points are crucially important for us who find ourselves increasingly defined by our data.

The crucial point can be stated in general form as follows: whatever is formatted can always be formatted in some other way according to many alternative formats. It is in this plurality of available formats that we can and should locate the politics and ethics of our encoding. Note well that the plurality of formats is not merely a matter of a plurality of possible descriptions. A format is not a fancy: multiple descriptions and interpretations are always easy to imagine, but format multiplicity is a function of rigorous scientific work such that the point concerns the production of stable, reliable, and well-earned formats. The politics of information is a politics of plural formats, a politics of the many different available formats that data channel our lives into. The politics of formats is not to be found in an emancipatory gesture that would finally free whatever cannot be coded from reductive programming by data. *The politics of formats is a function of the many ways in which data can code us: different options for coding produce different (and differently distributed) impacts.*

Take now a more extended, and also quite obviously nontrivial, example: the long history of attempts to discern genetic factors in various mental aptitudes such as intelligence. These attempts persist, as attested by two recent meta-analyses in *Nature*.[36] Any such effort in behavioral genetics (whether operationalized for intelligence at the group level or at the individual level) must come to terms with at least two dimensions within which there are multiple available formats for coding. For any research project in behavioral genetics, there are multiple reasonable formats available for both the behavioral component (the property being measured) and the genetic component (the biological-genetical correlate[s] of the behavioral property) of the research.

In the first dimension of what is being coded for, any inquiry into human intelligence must come to terms with the multiple reasonable conceptions of intelligence that a measurer might employ (analytical ability, factual memory, synthetic performance) as well as the multiple means through which those reasonable conceptions can be operationalized into codable data (multiple-choice tests, task-based exams, long-form essays). That there are different formats these ratings can take (and thus different scales according to which one might be rated low or high or neither) cannot be innocent. The many formats that data about our intelligence can take are charged precisely because there are multiple options available. I am not claiming that they are charged because of a purported immeasurability of intelligence. Rather, these are matters of political and ethical concern precisely because there are multiple reasonable methods for measuring intelligence.[37]

Differently measurable traits like intelligence represent only some of the choices that researchers face in seeking out genetic factors in who we are. There is also a plurality of viable routes for investigating sought-after genetic factors that may be validated as biological correlates (or even posited as biological causes) of measurable behavior. In this dimension, recent philosophy of science suggests that biological researchers "conceive of a plurality of mechanisms that generate continuity across generations in the biological sphere"[38] and that there are today a "diversity of disciplinary approaches, methods, assumptions and techniques characterizing biological research."[39] In other words, researchers in the genetic sciences find themselves facing a plurality of reasonable approaches from beginning to end and at every step along the way: there are multiple reasonable approaches to take at the outset with respect to the theoretical concepts that orient research, just as there are multiple reasonable ways of pursuing research in terms of the computational instruments at the heart of data-driven biology. For an example of plurality in concrete technological infrastructures, consider that researchers find themselves confronting multiple accepted biological ontologies for genetic annotation data, that is, multiple ways of designing a genetic database for formatting and storing genetic data and metadata.[40] For an example of plurality at the level of conceptual operation, consider the challenges posed by the widespread phenomena of "genomic mosaicism," in which cells from a single organism express multiple genotypes.[41]

There are multiple ways, at multiple levels, to format, or to define and implement, studies in behavioral genetics. Different approaches are bound to lead to disparate impacts on different groups and individuals. We therefore find ourselves in a situation in which data are differentially defining people and different differentials could also be implemented by deploying different data techniques. The informatics of genetics is, then, of such political and ethical concern because there are multiple reasonable codings for who we are, each of which carries different consequences for who we, and others, can be. These are concerns that come into view only under a distinctive infopolitical model.

In the midst of today's riotous enthusiasm for data sciences, we find it easy to neglect the subtler political and ethical dimensions of information. We are encouraged to think of data as a pure promise. There can be no doubt that data promises much that we should want. But no promise can bring only what is wanted. Just as biopolitics involves both productive operations of fostering life and the dangers of differentially declining to do so, so too does infopolitics involve both the promise of improving who we can be through aggressive data analytics and yet also the less-apparent perils of differentially neglecting to improve possibilities for some groups and individuals. If that is right, then there is in the midst of data-driven genetic sciences a politics of information itself.


## Acknowledgments

For comments on previous versions of this article, I am grateful to Joel Reynolds, Erik Parens, my esteemed colleague Nicolae Morar, an anonymous reviewer for this journal, and participants at the Hastings Center October 2018 conference "The Gift and Weight of Genomic Knowledge: In Search of the Good Biocitizen," for which this paper was originally developed.


1. My presentation of biopolitics follows perspectives rooted in the analyses of M. Foucault, *The History of Sexuality, Volume One: An Introduction*, trans. Robert Hurley (New York: Vintage Books, 1978); for a relatively recent perspective, see P. Rabinow and N. Rose, "Biopower Today," *BioSocieties* 1 (2006): 195-217.

2. My analysis of infopolitics throughout this essay builds on my previous work in C. Koopman, *How We Became Our Data:*

*A Genealogy of the Informational Person* (Chicago: University of Chicago Press, 2019).

3. These statements are taken from the following web pages, accessed at the time of writing: https://karmagenes.co, https://orig3n.com, and http://23andMe.com/en-int/.

4. N. Rose, *The Politics of Life Itself* (Princeton: Princeton University Press, 2007); N. Rose and C. Novas, "Biological Citizenship," in *Global Assemblages: Technology, Politics, and Ethics as Anthropological Problems*, ed. A. Ong and S. Collier (New York: Blackwell, 2004), 434-63; P. Rabinow, "Artificiality and Enlightenment: From Sociobiology to Biosociality" in *Essays on the Anthropology of Reason* (Princeton: Princeton University Press, 1996), 91-111.

5. See Foucault, *History of Sexuality*; Rabinow and Rose, "Biopower Today"; and more recently in this vein, see C. Dupras and V. Ravitsky, "Epigenetics in the Neoliberal 'Regime of Truth': A Biopolitical Perspective on Knowledge Translation," *Hastings Center Report* 46, no. 1 (2016): 26-35.

6. For a fuller defense of Foucault's methodology, see C. Koopman, *Genealogy as Critique: Foucault and the Problems of Modernity* (Bloomington, IN: Indiana University Press, 2013), 58-86.

7. Biopolitics is a politics of regulations in the sense of managerial modulation, not in the legal sense of regulations as policy mandates.

8. Foucault, *History of Sexuality*, 135-45.

9. Foucault, *History of Sexuality*, 88-91.

10. I cannot fully defend this historicist claim here; I only note that my approach overall relies on a distinction between Foucault's *genealogical method of analysis* and his development of a *concept of biopolitics* on the basis of his own genealogical research; for more on this, see C. Koopman and T. Matza, "Putting Foucault to Work: Analytic and Concept in Foucaultian Inquiry," *Critical Inquiry* 39, no. 4 (2013): 817-40.

11. J. Watson and F. Crick, "Genetical Implications of the Structure of Deoxyribonucleic Acid," in *The Double Helix,* ed. G. S. Stent (New York: W. W. Norton, 1980), 241-47, at 244.

12. J. Watson and F. Crick, "The Structure of DNA," in *The Double Helix*, ed. G. S. Stent (New York: W. W. Norton, 1980), 257-74, at 267.

13. Watson and Crick, "The Structure of DNA," 267.

14. J. Watson, "The Double Helix," in *The Double Helix*, ed. G. S. Stent (New York: W. W. Norton, 1980), 1-136, at 89. The idea of a unidirectional flow of genetic information from DNA and RNA to protein had by then been cemented as Crick's central dogma, one of his twin pillars of molecular biology. The other pillar was Crick's sequence hypothesis, the idea that the precise *sequence* of nucleic acid bases is a *code* that solely expresses the amino acid sequence of a protein. Crick's own language for these pillars is information rich: "the specificity of a piece of nucleic acid is expressed solely by the sequence of its bases, and that this sequence is a (simple) code for the amino acid sequence of a particular protein," and the central dogma "states that once 'information' has passed into protein it cannot get out again" (F. Crick, "On Protein Synthesis," *Symposia of the Society of Experimental Biology* 12 [1958]: 138-63, at 152).

15. F. Jacob, *The Logic of Life: A History of Heredity* (New York: Penguin, 1989), 1.

16. R. Dawkins, *A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (Boston: Houghton Mifflin, 2003), 28.

17. L. Kay, "Who Wrote the Book of Life? Information and the Transformation of Molecular Biology, 1945-55," *Science in Context* 8, no. 4 (1995): 609-34, at 610.

18. Kay, "Who Wrote the Book of Life?," 611.

19. Ibid., "Who Wrote the Book of Life?," 620. On 1948 as a turning point that aligns postwar genetics with militaristic techno-science, also see Ibid., 612; H. Stevens, *Life out of Sequence: A Data-Driven History of Bioinformatics* (Chicago: University of Chicago Press, 2013), 15; and J. Reardon, *The Postgenomic Condition: Ethics, Justice, and Knowledge after the Genome* (Chicago: University of Chicago Press, 2017), 40. This trope in the recent historiography of genetics is a repetition of a central trope of the historiography of information theory; for one prominent example, see F. Kittler, *Gramophone Film Typewriter*, trans. G. Winthrop-Young and M. Wutz (Stanford, CA: Stanford University Press, 1990), 259. I have argued that this trope is something of a massive simplification because it remains in need of a longer historical analysis; see C. Koopman, "Information before Information Theory: The Politics of Data beyond the Perspective of Communication," *New Media & Society* 21, no. 6 (2019): 1326-43.

20. Wiener to Haldane in 1948, as quoted in Kay, "Who Wrote the Book of Life?," 623.

21. Kay, "Who Wrote the Book of Life?," 625.

22. L. Kay, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford, CA: Stanford University Press, 2000), 39.

23. N. Wiener, *The Human Use of Human Beings: Cybernetics and Society* (London: Free Association Books, 1989), 103; see also N. Wiener, *God and Golem, Inc.* (Cambridge, MA: MIT Press, 1964), 36.

24. B. Ephrussi et. al., "Terminology in Bacterial Genetics," *Nature* 171 (1953): 701; see discussion in Kay, *Who Wrote the Book of Life? A History of the Genetic Code*, 58.

25. I have relied exclusively on Kay's work to make this point, but more recent historiography concurs with the basic outlines of her detailed analysis: see H. Rheinberger and S. Müller-Wille, *The Gene: From Genetics to Postgenomics*, trans. A. Bostanci (Chicago: University of Chicago Press, 2017); J. November, *Biomedical Computing: Digitizing Life in the United States* (Baltimore, MD: Johns Hopkins University Press, 2012); M. García-Sancho, *Biology, Computing, and the History of Molecular Sequencing: From Proteins to DNA, 1945-2000* (New York: Palgrave Macmillan, 2012).

26. The shift to postgenomic perspectives has only amplified biology's conceptual, technical, and practical investments in information. If in classical genetics "theoretical considerations preceded data generation," today "the research process itself is driven through data generation" (Rheinberger and Müller-Wille, *The Gene*, 106).

27. Koopman, *How We Became Our Data*, 1.

28. Kay, *Who Wrote the Book of Life? A History of the Genetic Code*, 1.

29. D. Haraway, "Race: Universal Donors in a Vampire Culture," chap. 6 in part 3 of *Modest_Witness@Second_Millenium. FemaleMan©_Meets_OncoMouse™: Feminism and Technoscience* (New York: Routledge, 1997), 213-66, at 247.

30. Kay, *Who Wrote the Book of Life? A History of the Genetic Code*, 3, 327.

31. This is not to deny that the infopolitical concern with formatting may, of course, resonate in important ways with other formulations of related problems.

32. See the full account in Koopman, *How We Became Our Data*.

33. Examples of this skeptical antireductivism abound in more critical scholarship on genetics; for a sophisticated variant that avoids dogmatic skepticism and that adopts a Foucauldian methodology similar to my own, see A. Rouvroy, *Human Genes and Neoliberal Governance* (New York: Routledge-Cavendish, 2008), 35-54.

34. For a convincing account of such practical exclusions qua practical, see S. Leonelli, *Data-centric Biology: A Philosophical Study* (Chicago: University of Chicago Press, 2016), 160-69.

35. These statements are taken from 23andMe's online sample reports, accessed at the time of writing at https://permalinks.23andme.com/pdf/samplereport_ancestrycomp.pdf and https://permalinks.23andme.com/pdf/samplereport_wellness.pdf.

36. See D. Posthuma et al. "Genome-Wide Association Meta-analysis in 269,867 Individuals Identifies New Genetic and Functional Links to Intelligence," *Nature Genetics* 50 (2018): 912-19; D. Posthuma et al., "Genome-Wide Association Meta-analysis of 78,308 Individuals Identifies New Loci and Genes Influencing Human Intelligence," *Nature Genetics* 49 (2017): 1107-12. The first of these studies reports confirmation of three genomic loci and twelve genes for and identification of fifteen new genomic loci and forty new genes for "intelligence."

37. For a canonical work making this point, see S. J. Gould, *The Mismeasure of Man* (New York: W. W. Norton, 1980); for a more recent analysis from a psychological perspective, see R. Nisbett et al., "Intelligence: New Findings and Theoretical Developments," *American Psychologist* 67, no. 2 (2012): 130-59; and for a recent analysis developing related ideas from an intriguing philosophical-historical perspective close to my own, see C. Malabou, *Morphing Intelligence: From IQ Measurement to Artificial Brains*, trans. C. Shread (New York: Columbia University Press, 2019).

38. Rheinberger and Müller-Wille, *The Gene*, 115.

39. Leonelli, *Data-centric Biology*, 24.

40. Stevens, *Life out of Sequence*, 113.

41. J. Dupré, "The Polygenomic Organism," in *Postgenomics: Perspectives on Biology after the Genome*, ed. S. Richardson and H. Stevens (Durham, NC: Duke University Press, 2015), 56-72, at 62.